



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2022/2023**

- COURSE NAME : PRINCIPLE OF PHYSIOLOGICAL DEVICES
- COURSE CODE : BEJ 45203 / BEU 30203
- PROGRAMME CODE : BEJ
- EXAMINATION DATE : FEBRUARY 2023
- DURATION : 3 HOURS
- INSTRUCTION
1. ANSWER ALL QUESTIONS
  2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
  3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

**TERBUKA**

**CONFIDENTIAL**

- Q1** (a) Bioelectric potential results from the electrochemical activity of excitable cells such as neurons and muscle cells. Classify **TWO (2)** states involved in bioelectric potential. (6 marks)
- (b) Draw the technique of measuring the half-potential and explain the process of establishing a half-cell potential when a piece of metal is placed into a solution containing ions of that metal. (8 marks)
- (c) A differential amplifier has a positive input terminal, a negative input terminal, and a ground connection. Electrocardiogram (ECG) electrodes from a patient are connected to the positive and negative terminals, and a reference electrode is connected to ground. A disturbance signal develops on the patient's body. This will appear as a voltage from the positive terminal to ground and a similar voltage from the negative terminal to ground. Based on your evaluation,
- (i) Recommend an idea to amplify the ECG signal without amplifying the noise signals. (3 marks)
- (ii) Choose the ECG electrodes connection technique that connects the patient to the amplifier. Show your diagram. (4 marks)
- (d) (i) Describe the function of an electrode in measuring bioelectric signals. (3 marks)
- (ii) List **TWO (2)** types of electrodes used for recording electromyogram (EMG) signal and the other **TWO (2)** types of electrodes used for recording electrocardiogram (ECG) signal. (4 marks)
- Q2** (a) **Figure Q2(a)** shows the ECG tracing of a person at resting condition. The same person measured the blood pressure with a portable meter and found to be 123/82 mmHg.
- (i) By using the graph, find the person's heart rate. (3 marks)
- (ii) Estimate the person's pulse pressure. (2 marks)
- (iii) Calculate the mean atrial pressure and cardiac output for this person if the stroke volume of the person is  $80 \text{ cm}^3$ . (4 marks)

- (b) (i) Based on your knowledge, suggest any preferable portable device for indirectly measuring blood pressure that is available in the market. (3 marks)
- (ii) Decide any modification or improvement that can be applied to the device in part **Q2(b)(i)**. Justify your ideas and suggestions. (6 marks)
- (iii) Hence, sketch the prototype of the improvised blood pressure measurement device in part **Q2(b)(ii)**. (5 marks)

- Q3** (a) A blood specimen has a hydrogen ion concentration of 40 nmol/liter and a partial pressure of carbon dioxide ( $P_{CO_2}$ ) of 60 mmHg. Calculate the pH value. Predict the type of acid-base abnormality that the patient exhibits. (5 marks)
- (b) There are **FOUR(4)** components in biosensor. Discuss the components and their function. (8 marks)
- (c) Choose a commercially successful type of biosensor and justify its importance to the society. (7 marks)

- Q4** (a) Transducer is a device that converts energy into a corresponding signal with a different energy form. It takes the form of a sensor and an actuator.
- (i) Differentiate between a sensor and an actuator. (4 marks)
- (ii) A potentiometer is the simplest linear displacement transducer to form an adjustable voltage divider. With the aid of a diagram, explain the operating principle of a potentiometer (8 marks)
- (b) An unknown temperature is measured with a type K thermocouple and a thermocouple voltage of 2602  $\mu V$  is measured. If the cold junction temperature is 20 °C, calculate the process temperature, measured by the hot junction side of the thermocouple. Use the temperature conversion table as shown in **Table Q4(b)** to find the temperature from the measured voltage. (10 marks)

- (c) A  $10\text{ k}\Omega$  Negative Temperature Coefficient (NTC) thermistor has a material constant ( $\beta$ ) value of  $3455\text{ K}$  between the temperature range of  $25^\circ\text{C}$  to  $100^\circ\text{C}$ . Calculate its resistive value at  $25^\circ\text{C}$  and  $100^\circ\text{C}$ .

(7 marks)

**- END OF QUESTIONS -**

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**Figure Q2(a)**

**Table Q4(b)**

deg C	0	1	2	3	4	5	6	7	8	9
0	0	39	79	119	158	198	238	277	317	357
10	397	437	477	517	557	597	637	677	718	758
20	798	838	879	919	960	1000	1041	1081	1122	1163
30	1203	1244	1285	1326	1366	1407	1448	1489	1530	1571
40	1612	1653	1694	1735	1776	1817	1858	1899	1941	1982
50	2023	2064	2106	2147	2188	2230	2271	2312	2354	2395
60	2436	2478	2519	2561	2602	2644	2685	2727	2768	2810
70	2851	2893	2934	2976	3017	3059	3100	3142	3184	3225
80	3267	3308	3350	3391	3433	3474	3516	3557	3599	3640
90	3682	3723	3765	3806	3848	3889	3931	3972	4013	4055
100	4096	4138	4179	4220	4262	4303	4344	4385	4427	4468